

**PROCEDURES FOR
ASSEMBLY, DISASSEMBLY,
AND INSPECTION (PADI)
OF THE
HYBRID III 50TH PERCENTILE DUMMY'S
NINE ACCELEROMETER ARRAY HEAD (NAAH)
WITH REDUNDANT HEAD C.G. ACCELEROMETERS**

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1.0 INTRODUCTION

1.1 Foreword

The nine accelerometer array head is so named because nine accelerometers are installed within the head for studying head angular motion. Three of these accelerometers are located at the center of gravity (c.g.) of the head, and the remaining six are located two each at the top, left side and front of the skull. This nine linear accelerometer scheme allows the linear acceleration at the c.g. and the head angular accelerations in time to be directly determined by three simple formulas. In addition, another three linear accelerometers are used at the head c.g. as redundants for determining the resultant head acceleration. In the event one of the primary accelerometers at the c.g. fails during a very costly crash test, these redundant accelerometers will provide the measurements necessary to calculate the resultant head accelerations required for determining HIC values.

The National Highway Traffic Safety Administration has prepared this document under the title “Procedures for Assembly, Disassembly, and Inspection of the Hybrid-III 50th Percentile Nine Accelerometer Array Head with Redundant Head C.G. Accelerometers,” otherwise known as “PADI for the H-III50th NAAH With Redundant C.G. Accelerometers.” The document is based on drawings from Robert A. Denton, Incorporated. The NAAH With Redundant C.G. Accelerometers is depicted in Figure 1.1. Its size, weight distribution, and moment of inertia are that of an average 50th Percentile adult. This special head is used for assessing head injuries in motor vehicle crashes.

1.2 Purpose

This document contains procedures for assembly, disassembly, inspection, and adjustments of the H-III50th NAAH With Redundant C.G. Accelerometers to assure the head is properly prepared and adjusted for testing. The head calibration tests are unchanged from those in Part 572 Subpart E and ensure the head is capable of repeatable and reproducible performance while its responses remain within the biofidelity corridors. This document is a guide for the user to properly inspect, assemble, and adjust the H-III50th NAAH With Redundant C.G. Accelerometers as needed.

1.3 Part Numbers

All parts in this procedure refer to Figures 1.1, 1.2, and to the drawing package specified in the Part 572 Subpart E. The part number for the nine accelerometer array head mount with redundant accelerometers is Denton Drawing No. B-5046-D dated 12/19/00. The accelerometers are Part Number SA572-S4 as specified in Figure 1.2. The weight and c.g. specifications are identical to those specified for the Hybrid III 50th Percentile Male Dummy head on GM drawings 78051-61X and 78051-338. Drawing copies for the Subpart E dummy can be obtained from Reprographics Technologies, 9000 Virginia Manor Road, Beltsville, MD 20705; Telephone (301) 210-5600.

1.4 Abbreviations and References

The abbreviations for threaded fasteners used throughout the procedure are listed in Table 1.1.

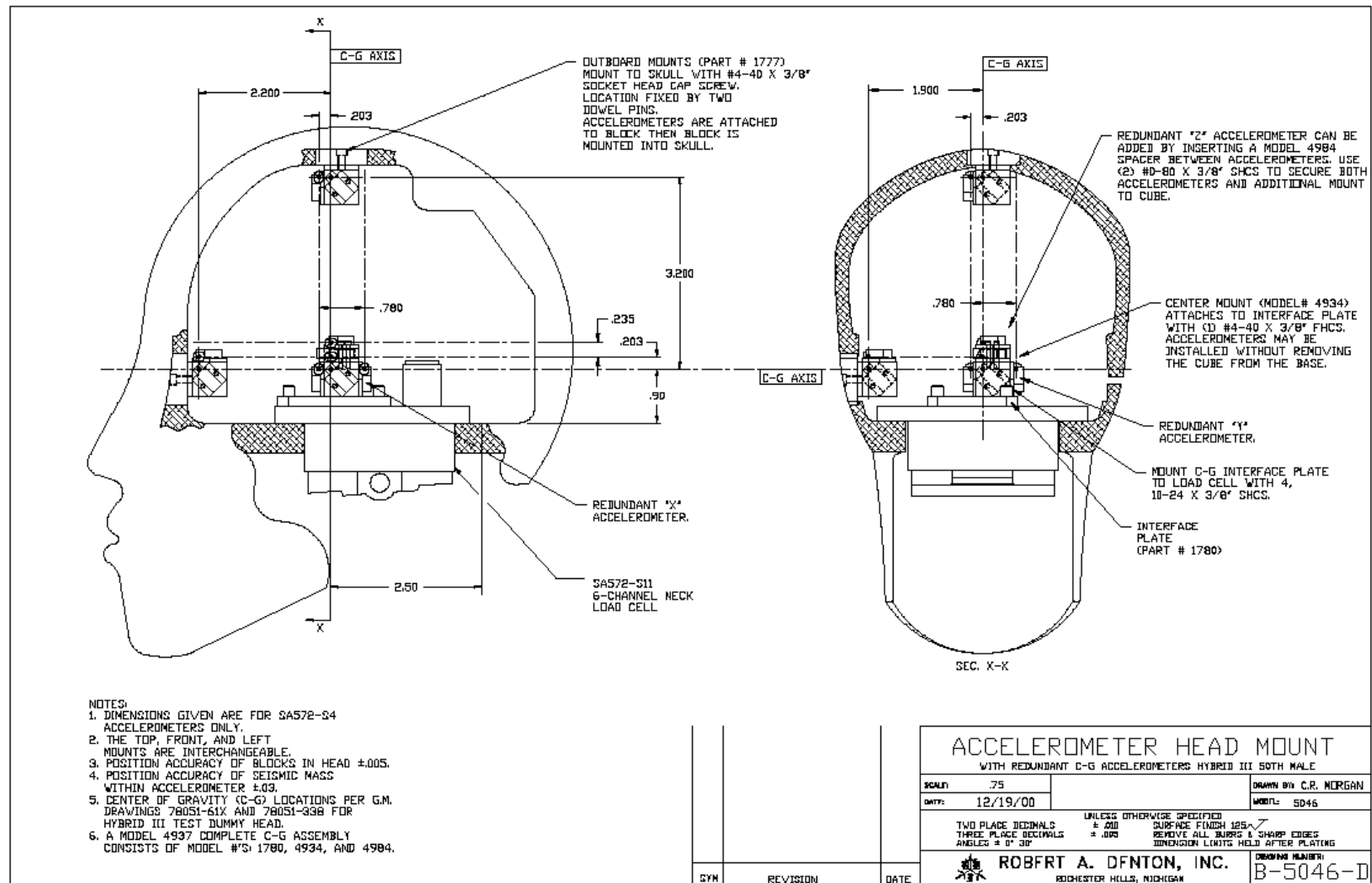


Figure 1.1 -- Nine Accelerometer Array Head With Redundant C.G. Accelerometers

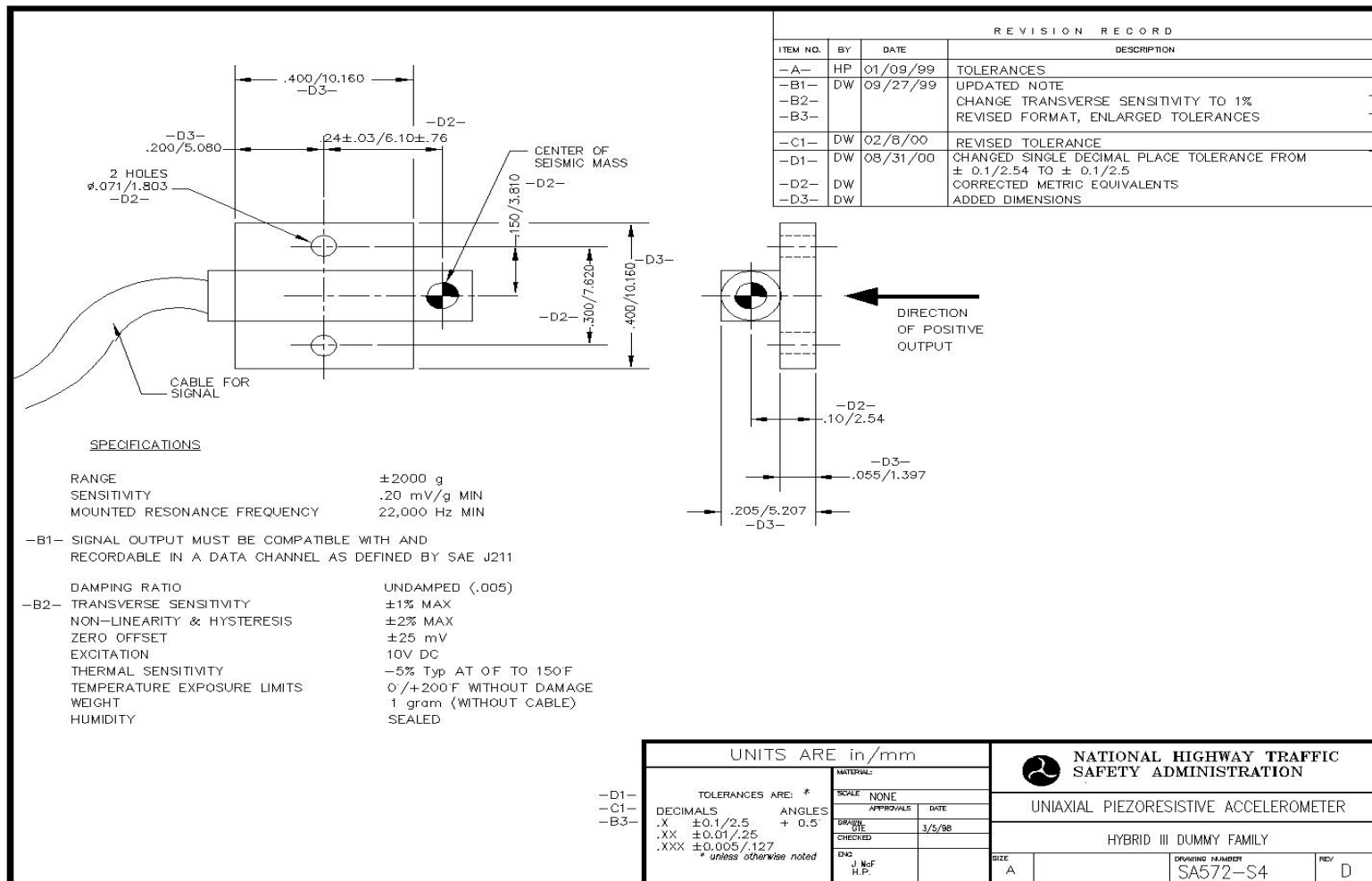


Figure 1.2 -- SA572-S4 Uniaxial Piezoresistive Accelerometer

Table 1.1 -- Threaded Fasteners

Abbreviation	Description
SHCS	Socket Head Cap Screw
FHCS	Flat Head Cap Screw
BHCS	Button Head Cap Screw

The parts specific to the NAAH are included on the drawing in Figures 1.1 and 1.2. Some references are made to parts from the Hybrid III 50th percentile Part 572, Subpart E Dummy Drawings. These drawings are not included.

1.5 Torque Specifications

The torque requirements for the screws used throughout the dummy head are shown in Table 1.2.

Table 1.2 -- Screw Torques

Screw Type	Size (English)	Torque (in-lb)	Torque (Nm)
SHCS/FHCS/BHCS	0-80	As Required	
	4-40		
	10-24, 10-32	90	10.2
	1/4 - 20, 1/4 -28	190	21.5

2.0 HEAD CONSTRUCTION - NINE ACCELEROMETER ARRAY WITH REDUNDANT C.G. ACCELEROMETERS

The nine accelerometer array with redundant c.g. accelerometers head construction consists of a modified Hybrid III 50th percentile skull (Figure 1.1) containing three mounting pads permanently inserted into the skull and the following parts which can be disassembled from the skull:

- a. Three outboard triaxial mounts (Part No. 1777) for uniaxial accelerometers (only two of the three axes per mount are used) accommodating six accelerometers.
- b. A c.g. assembly (Model No. 4937) consisting of center mount (Model No. 4934), a spacer (Model No. 4984), and an interface plate (Part No. 1780). This assembly accommodates six uniaxial accelerometers.

The four special accelerometer mounts are specifically located at:

1. The c.g. of the head mounted on top of the upper neck load cell or its structural replacement
2. The top of the head directly above the c.g.
3. The front of the head directly forward of the c.g.
4. The left side of the head directly lateral of the c.g.

The formulas for determining angular accelerations at the c.g. use the following distances between the head c.g. (center of seismic masses) and the outboard mount axis centers:

1. C.G. to left side = 1.900 inches
2. C.G. to front = 2.200 inches
3. C.G. to top = 3.200 inches

2.1 Instrumentation

The NAAH With Redundant C.G. Accelerometers has provisions for mounting accelerometers oriented in the direction specified in Table 2.1. It also accommodates an upper neck load cell.

Table 2.1 -- Nine Accelerometer Array and Redundant Accelerometer Orientations

NAAH Transducer	Part No.	Location	Axis	Expected Direction of Positive Accelerometer Output wrt NHTSA's Coordinate System*
Head Accelerometer	SA572-S4	Head C.G.	x	+
		Head C.G.	y	-
		Head C.G.	z	-
		Head C.G. Redundant	x	-
		Head C.G. Redundant	y	+
		Head C.G. Redundant	z	-
		Top	x	+
		Top	y	-
		Front	y	-
		Front	z	-

		Left Side	x	+
		Left Side	z	-

* Forward, right and down are positive in accordance with NHTSA's coordinate system.

3.0 PROCEDURES FOR ASSEMBLY, DISASSEMBLY, AND INSPECTION

3.1 Head Assembly

The nine accelerometer array with redundant c.g. accelerometers head for the Hybrid III 50th percentile dummy is shipped from the manufacturer to NHTSA assembled without accelerometers but having the correct center of gravity and weight. It is necessary to disassemble the head to install any electronic instrumentation the user requires.

The following procedure is recommended for installation of the twelve accelerometers (SA572-S4) in the NAAH head. It should be noted that the upper neck load cell (SA572-S11) or its structural replacement (Drawing 78051-383X) cannot be put in or taken out if the left outboard accelerometer mount is attached.

The procedure covers:

- a. Removing from the head the upper neck load cell structural replacement (Drawing 78051-383X), outboard mounts (Part No. 1777) and c.g. assembly (Model No. 4937, Figure 1.1)
- b. Attaching the accelerometers to mounts
- c. Installing the mounts in the head

Note: The load cell structural replacement may be replaced with an upper neck load cell (SA572-S11).

1. Remove the skull cap/skull cap skin assembly (Drawings 78051-221/ 78051-229) by taking out the four 1/4 - 20 x 5/8" SHCSs that hold the skull cap to the skull to expose the accelerometer head mount with redundant c.g. accelerometers as shown in Figure 1.1.
2. Remove the head skin (78051-228).
3. Remove the left outboard accelerometer mount (Part No. 1777, Figure 1.1) from the dummy head by removing the #4-40 x 3/8" SHCS from the left outer side of the skull (Figure 1.1).

- a. Attach two accelerometers (Part No. SA572-S4, Figure 1.2) in the X and Z directions to the left outboard mount using #0-80 UNF x 1/8" SHCS in accordance with Figure 1.1. Orient the accelerometers per Figure 1.1 and Table 2.1. Label the accelerometer wires "X and Z left."
4. Remove the load cell structural replacement (Drawing 78051- 383X) by removing the four 1/4 - 28 x 7/8" SHCSs and corresponding 1/4" ID x 3/8" OD washers.
 - a. If using an SA572-S11 upper neck load cell remove the c.g. assembly (Model No. 4937, Figure 1.1) from the load cell structural replacement (Drawing 78051- 383X) by removing the four #10-24 x 3/8" SHCSs attached to the interface plate (Part No. 1780).
5. Remove the front outboard mount (Part No. 1777, Figure 1.1) by removing the #4-40 x 3/8" SHCS from the front outer surface of the head.
 - a. Attach two accelerometers (Part No. SA572-S4, Figure 1.2) in the Y and Z directions to the front outboard mount using #0-80 UNF x 1/8" SHCSs in accordance with Figure 1.1. Orient the accelerometers per Figure 1.1 and Table 2.1. Label the accelerometer wires "Y and Z front."
6. Remove the top outboard mount (Part No. 1777, Figure 1.1) by removing the #4-40 x 3/8" SHCS from the top outer surface of the head.
 - a. Attach two accelerometers (Part No. SA572-S4, Figure 1.2) in the X and Y directions to the top outboard mount using #0-80 UNF x 1/8" SHCSs in accordance with Figure 1.1. Orient the accelerometers per Figure 1.1 and Table 2.1. Label the accelerometer wires "X and Y top."
7. Install the front and top outboard mounts (Part No. 1777, Figure 1.1) with accelerometers to their corresponding permanently fastened pads in the front and top of the skull. Note that the mounts can be installed on the pad dowel pins in only one way for the # 4-40 screw to properly align the mount to the pad. Also, note that these outboard mounts are made of aluminum and are subject to internal thread stripping.
 - a. These permanently fastened pads have two small dowel pins and a thru hole for a #4-40 x 3/8" SHCS for attaching to outboard mounts. A typical permanently fastened mounting pad as viewed from the rear side of the skull is shown in Figure 3.1.
 - b. Make sure the accelerometers are properly oriented as per Figures 1.1, 3.2, 3.3, and Table 2.1.
 - c. Figure 3.4 shows that the #4-40 x 3/8" SHCS is accessed from outside the head.

8. Install the six accelerometers (Part No. SA572-S4, Figure 1.2) in the X, Y, and Z directions on the c.g. assembly (Model No. 4937, note 6 on Figure 1.1) on the upper neck load cell (SA572-S11) or load cell structural replacement (Drawing 78051- 383X) after assembling the mounts as described below.
- a. If not already in place, attach the center mount (Model No. 4934, Figure 1.1) to the interface plate (Part No. 1780, Figure 1.1) by accessing the #4-40 x 3/8" FHCS on the bottom of the interface plate (Figure 3.5). Note that the center mount can be installed on the interface plate in only one way for the # 4-40 screw to properly align the mount to the interface plate. Also, note that the center mount is made of aluminum and is subject to internal thread stripping.
 - b. Attach the interface plate (Part No. 1780, Figure 1.1) and center mount (Model No. 4934, Figure 1.1) to the upper neck load cell SA572-S11 or structural replacement (Drawing 78051- 383X) with four #10-24 x 3/8" SHCSs. Two locator pins assure proper alignment of the interface plate on the load cell or load cell structural replacement. The interface plate has clearance spaces for the accelerometer cables so that the thru holes in the accelerometer can be aligned with the #0-80 UNF holes in the center mount. (Figures 3.5 and 3.6). A perspective view of the assembly is shown in Figure 3.7.
 - c. Attach four accelerometers (Part No. SA572-S4, Figure 1.2) in the X and Y directions using #0-80 UNF x 1/8" SHCSs, and two accelerometers (Part No. SA572-S4, Figure 1.2) in the Z direction to the center mount (Model No. 4934, Figure 1.1) using the "U" shaped spacer (Model No. 4984, Figure 1.1) and two #0-80 UNF x 3/8" SHCSs. Orient the accelerometers per Figures 1.1 and 3.8, and Table 2.1. Label the accelerometer wires "Head X Center, Head Y center, Head Z Center, Head X Redundant, Head Y Redundant, Head Z Redundant."
 - d. Attach the wires to the wire tie anchor on the load cell SA572-S11 (Figures 3.7 and 3.8).

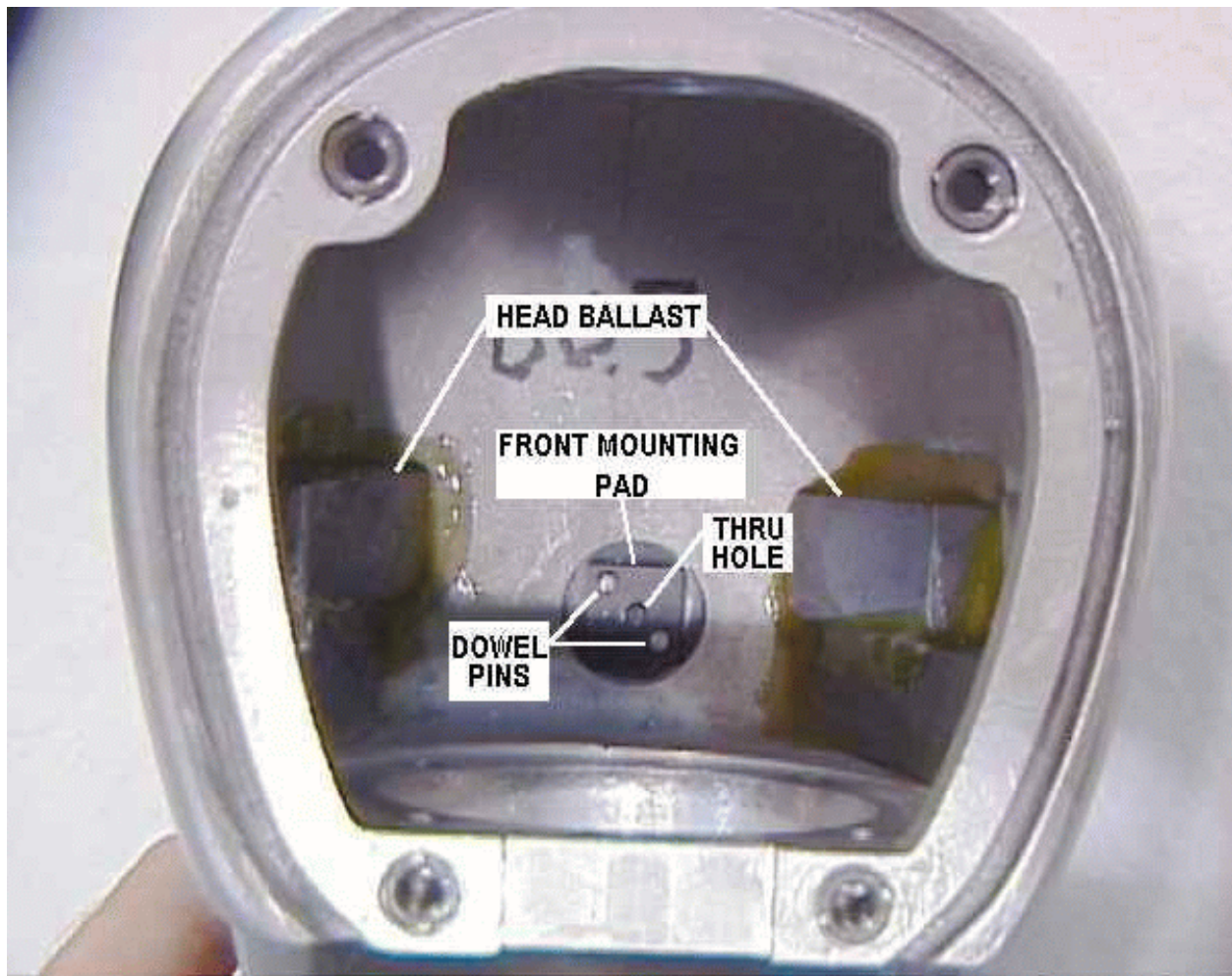


Figure 3.1 -- Front mounting pad (permanently installed) (left and top pads are not shown)

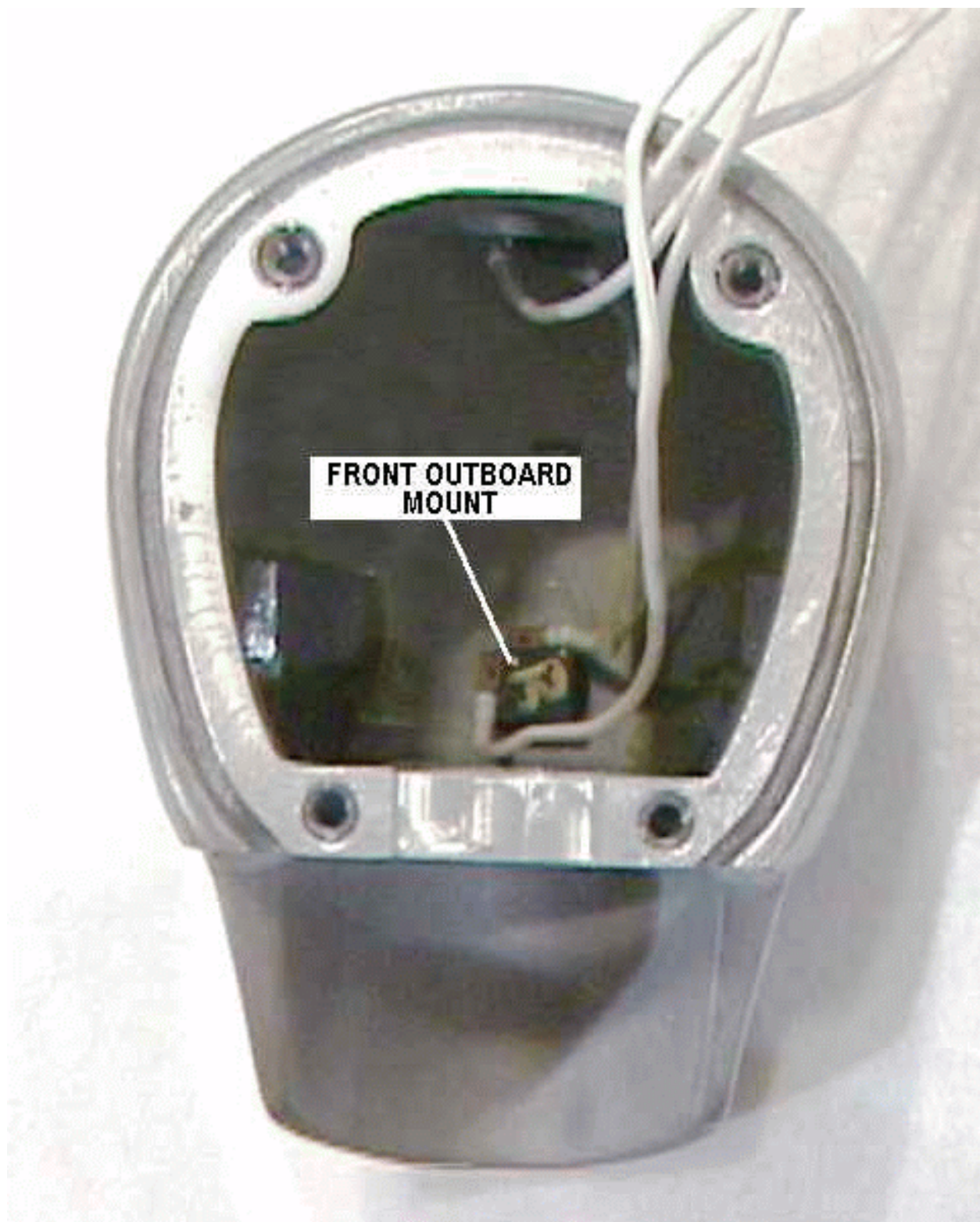


Figure 3.2 -- Rear view of accelerometers on front outboard mount installed in skull



Figure 3.3 -- Bottom view of accelerometers on top outboard mount installed in skull

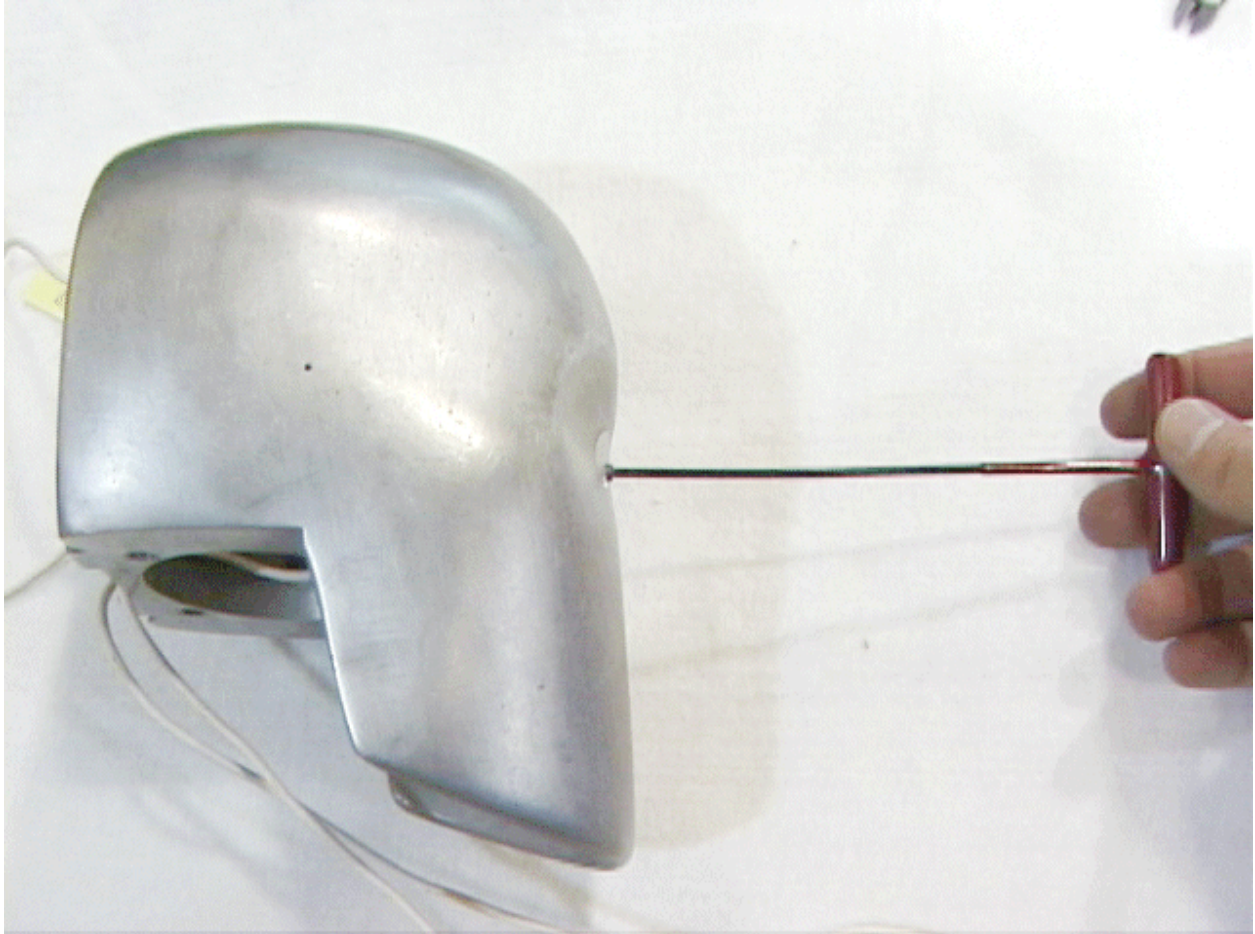


Figure 3.4 -- Attach outboard mounts to permanently fastened mounting pad from the outside

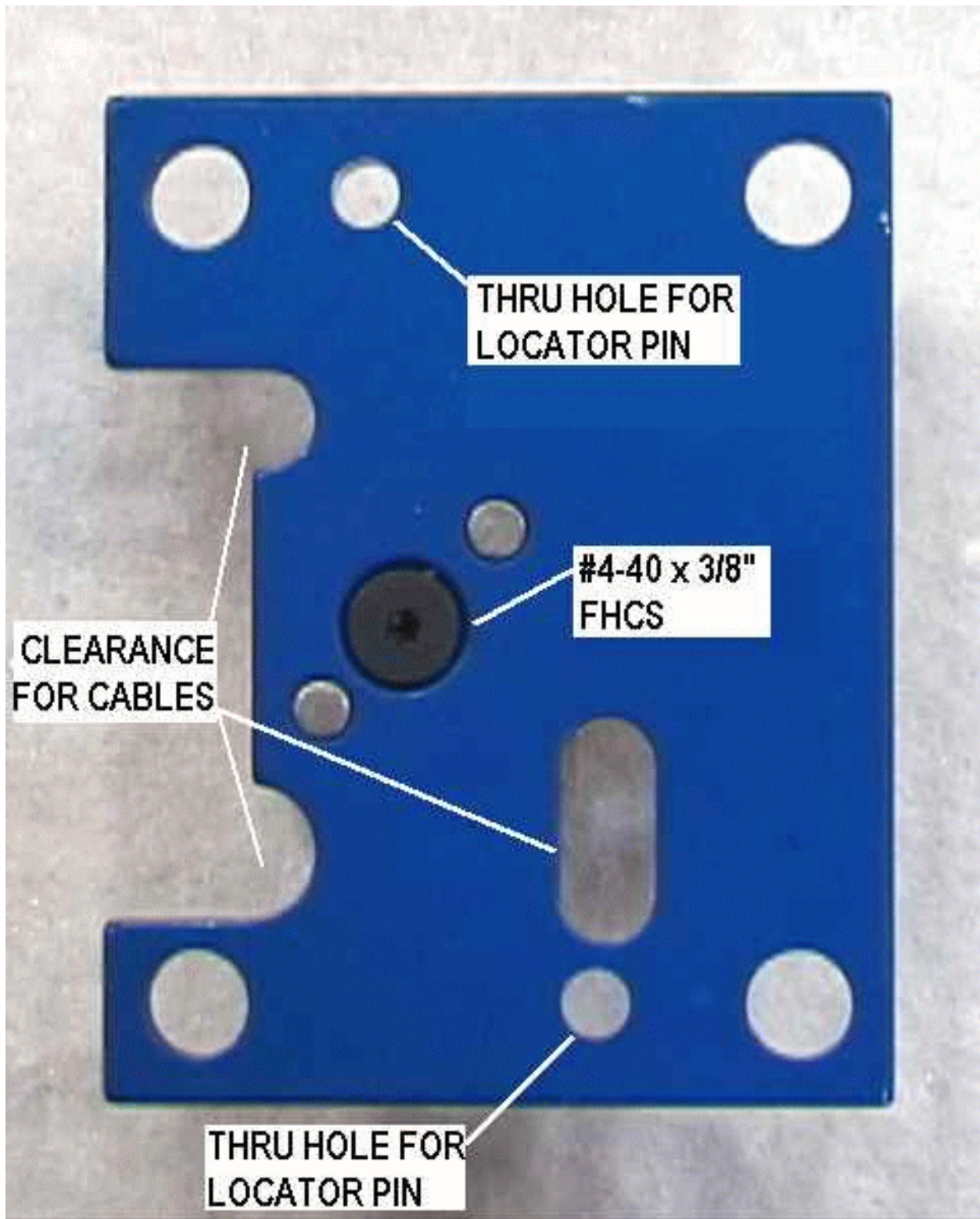


Figure 3.5 -- Bottom view of interface plate with screw for attaching to center mount

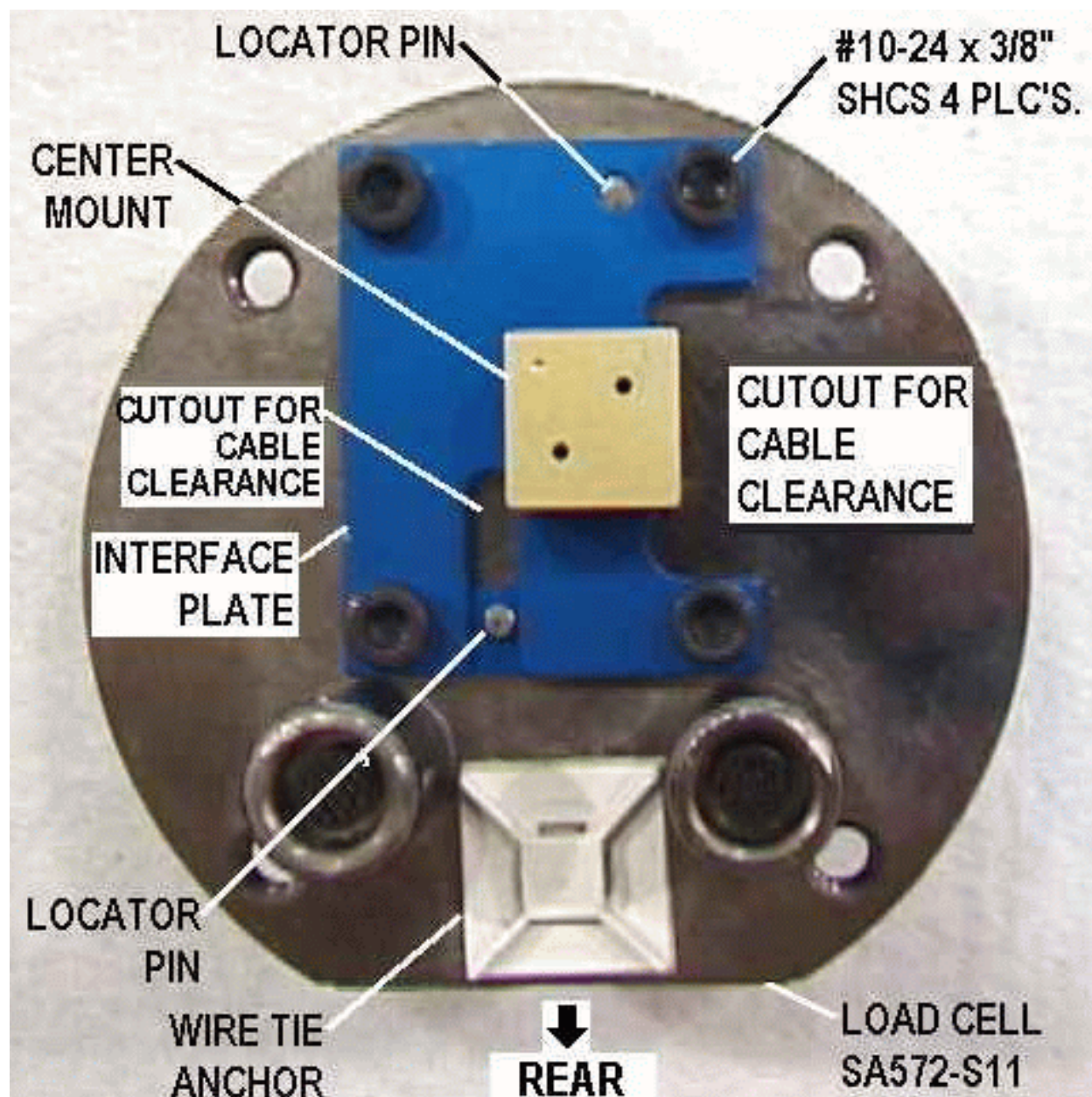


Figure 3.6-- Interface plate and center mount installed on load cell (top view)

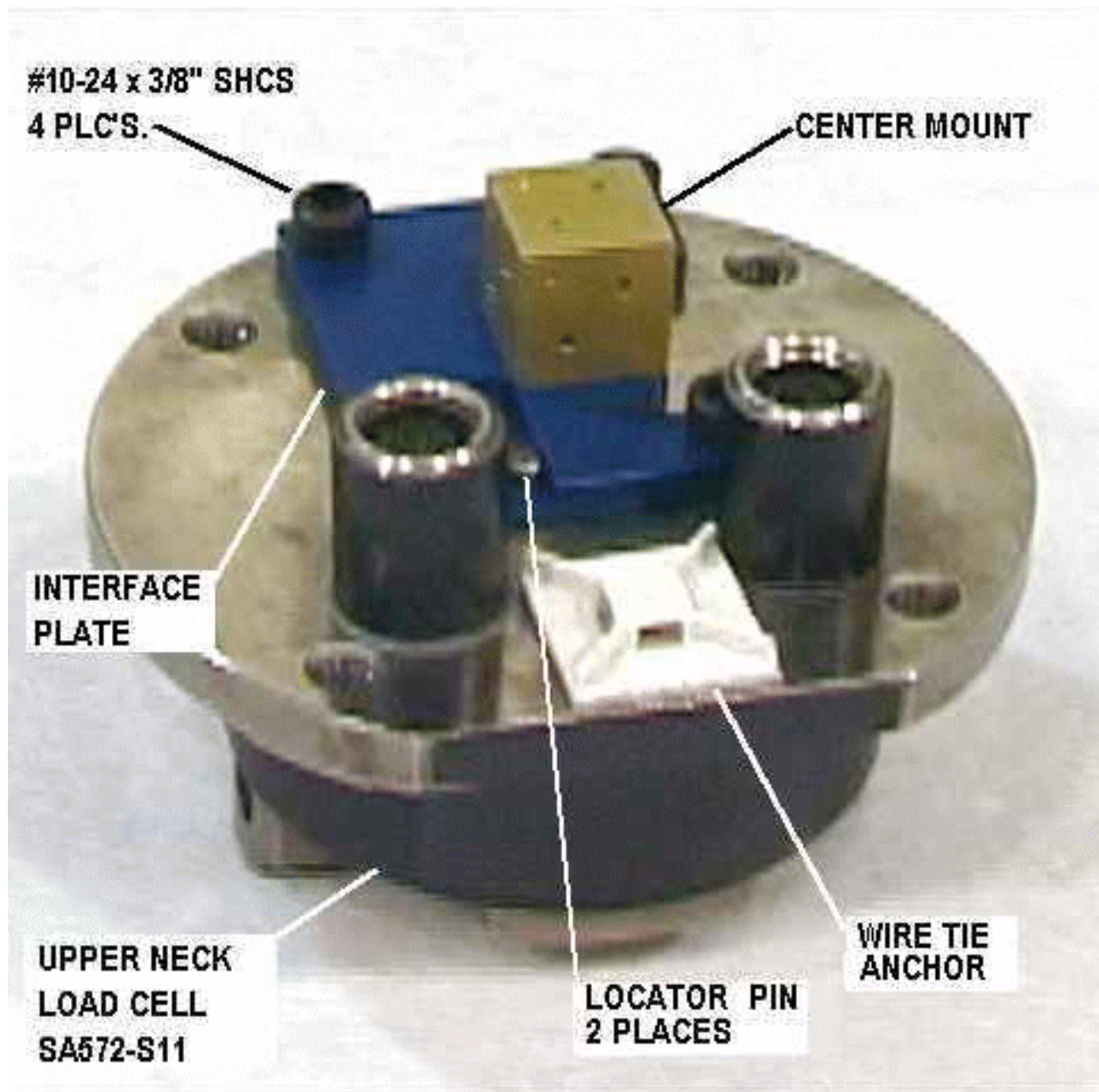


Figure 3.7 -- Interface plate and center mount installed on load cell (perspective view)

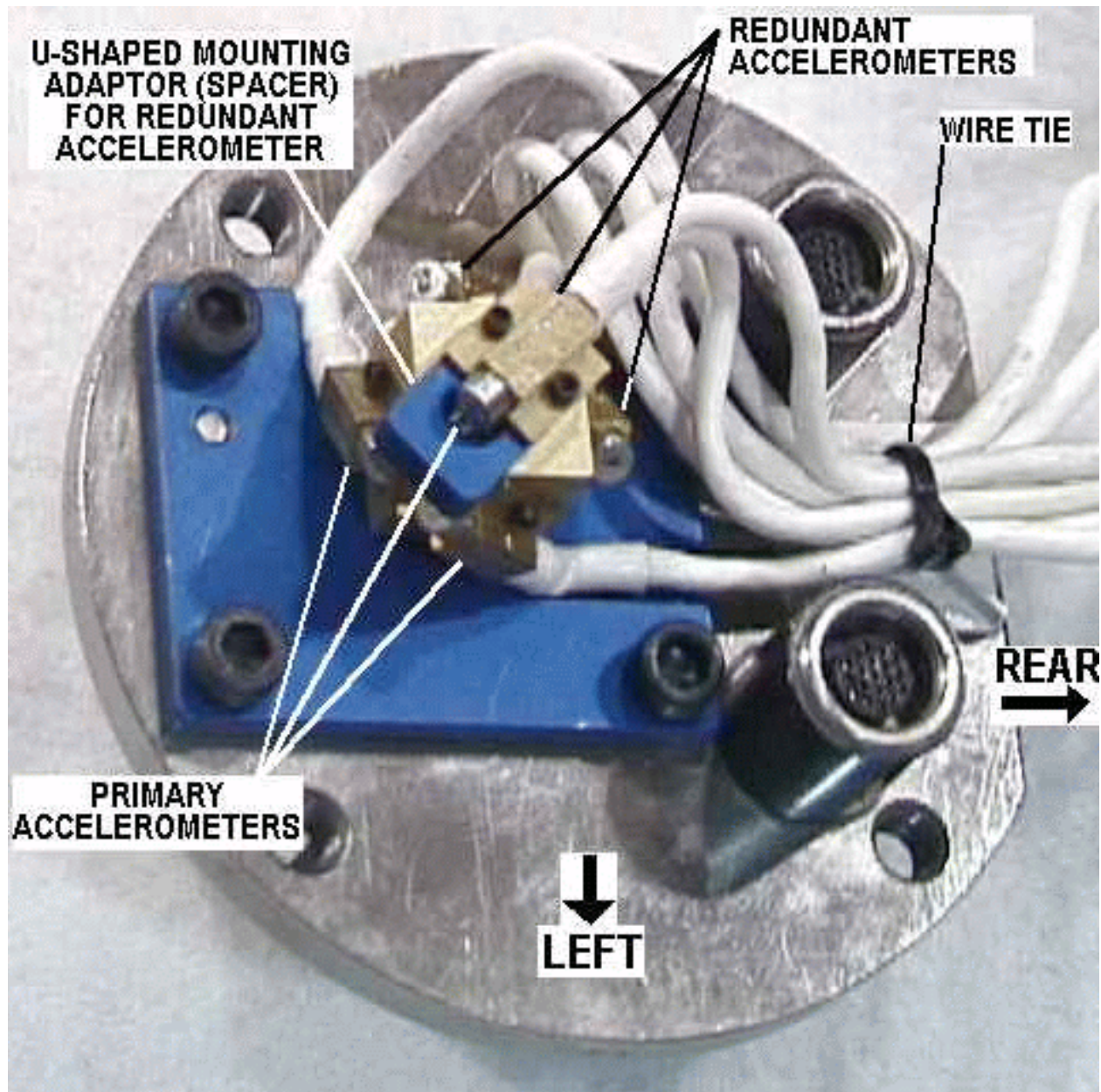


Figure 3.8 -- Perspective view of accelerometers on c.g. assembly and load cell

9. Install the SA572-11 upper neck load cell or load cell structural replacement (Drawing 78051- 383X) with its c.g. and redundant mounted accelerometers (Part No. SA572-S4, Figure 1.2) in the dummy head by completing the following task.

Insert the SA572-11 upper neck load cell or its structural replacement (Drawing 78051- 383X) with its accelerometers into the head and lower it into the thru hole. Secure with the four 1/4 - 28 x 7/8" SHCSs and 1/4" ID x 3/8" OD washers from the underside of the head. The installation of the top, front and center accelerometers and load cell is pictured in Figure 3.9.

10. Install the outboard mount (Part No. 1777) with accelerometers by attaching a #4-40 x 3/8" SHCS from the left outer surface of the head. Note that the mount can be installed on the pad dowel pins in only one way for the # 4-40 screw to properly align the mount to the pad. Also, note that the outboard mount is made of aluminum and is subject to internal thread stripping. Attach the load cell cables to the load cell if they are not already connected. The installation is pictured in Figure 3.10. The orientation of the accelerometers should agree with Figure 1.1 and Table 2.1.
11. Install the head skin (Figure 3.11).
12. Allowing some strain relief in the head, route the cables in a flat bundle in the recess at the rear base of the head so they are not pinched when installing the skull cap. Use the wire tie anchor and wire ties as required (Figure 3.11). Duct tape can be temporally used to keep the wires off the skull cap mating surface (Figure 3.11).
13. Install the skull cap and its skin assuring the cables are not pinched and remove the duct tape (Figure 3.12).

3.2 Head Disassembly And Inspection

Disassembly of the nine accelerometer array head is in reverse order from its assembly.

The outboard mounts (Part No. 1777, Figure 1.1) and center mount (Model No. 4934, Figure 1.1) used to hold accelerometers are made of aluminum and are subject to internal thread stripping. During disassembly they should be inspected and replaced if needed.

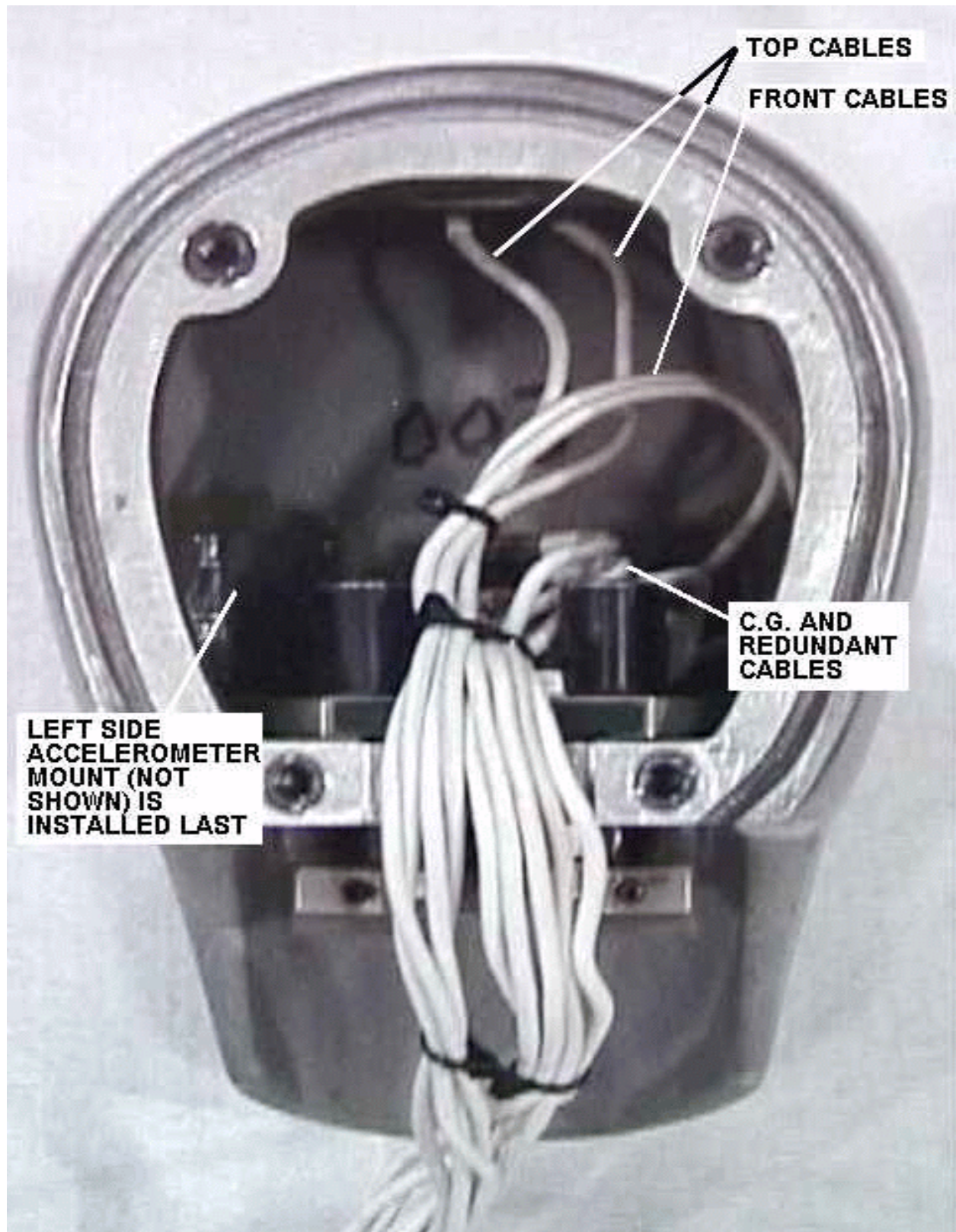


Figure 3.9 -- Rear view of top, front, and center accelerometers installed in skull

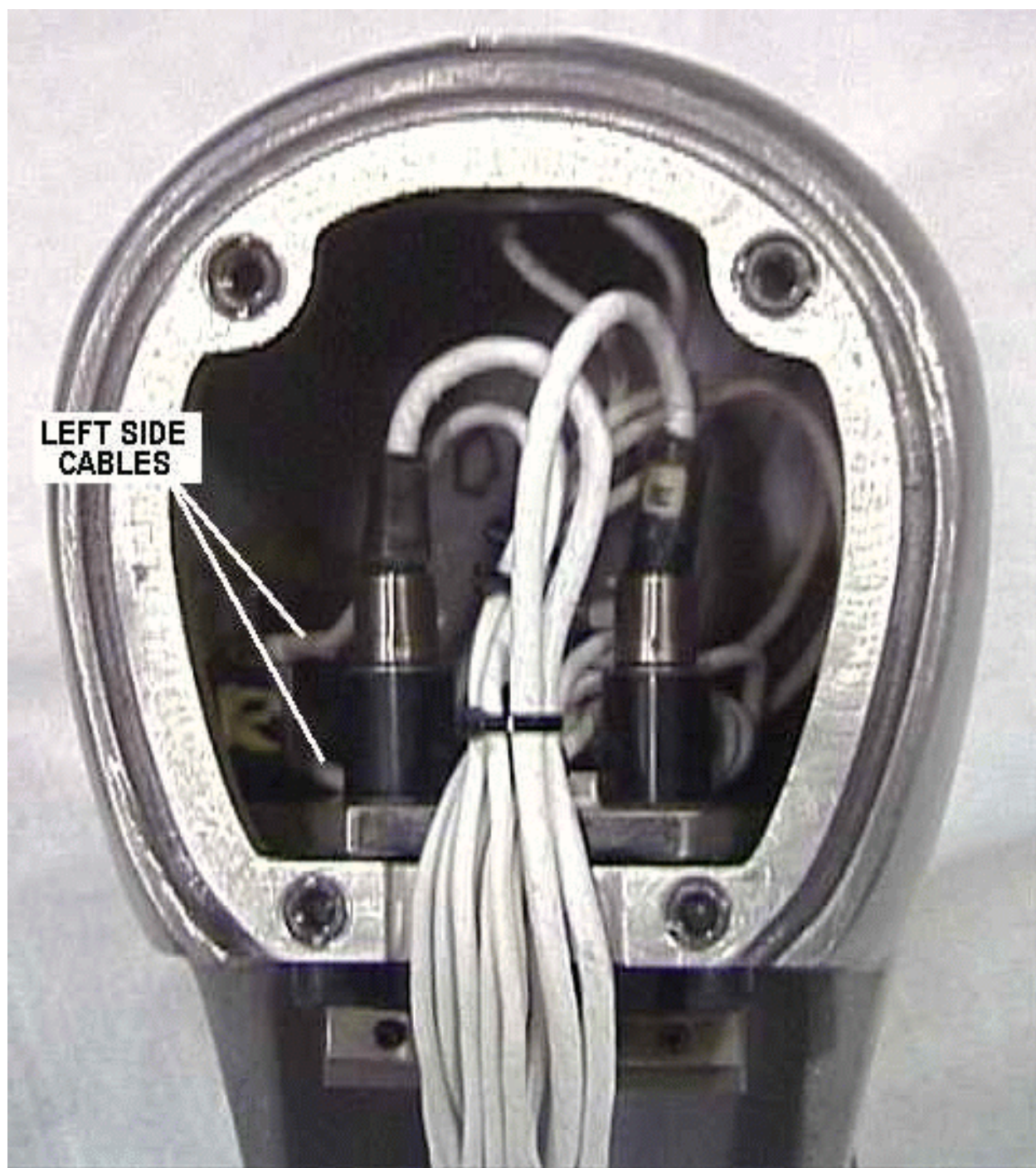


Figure 3.10 -- Nine accelerometers plus three c.g. redundant accelerometers and a load cell installed in skull

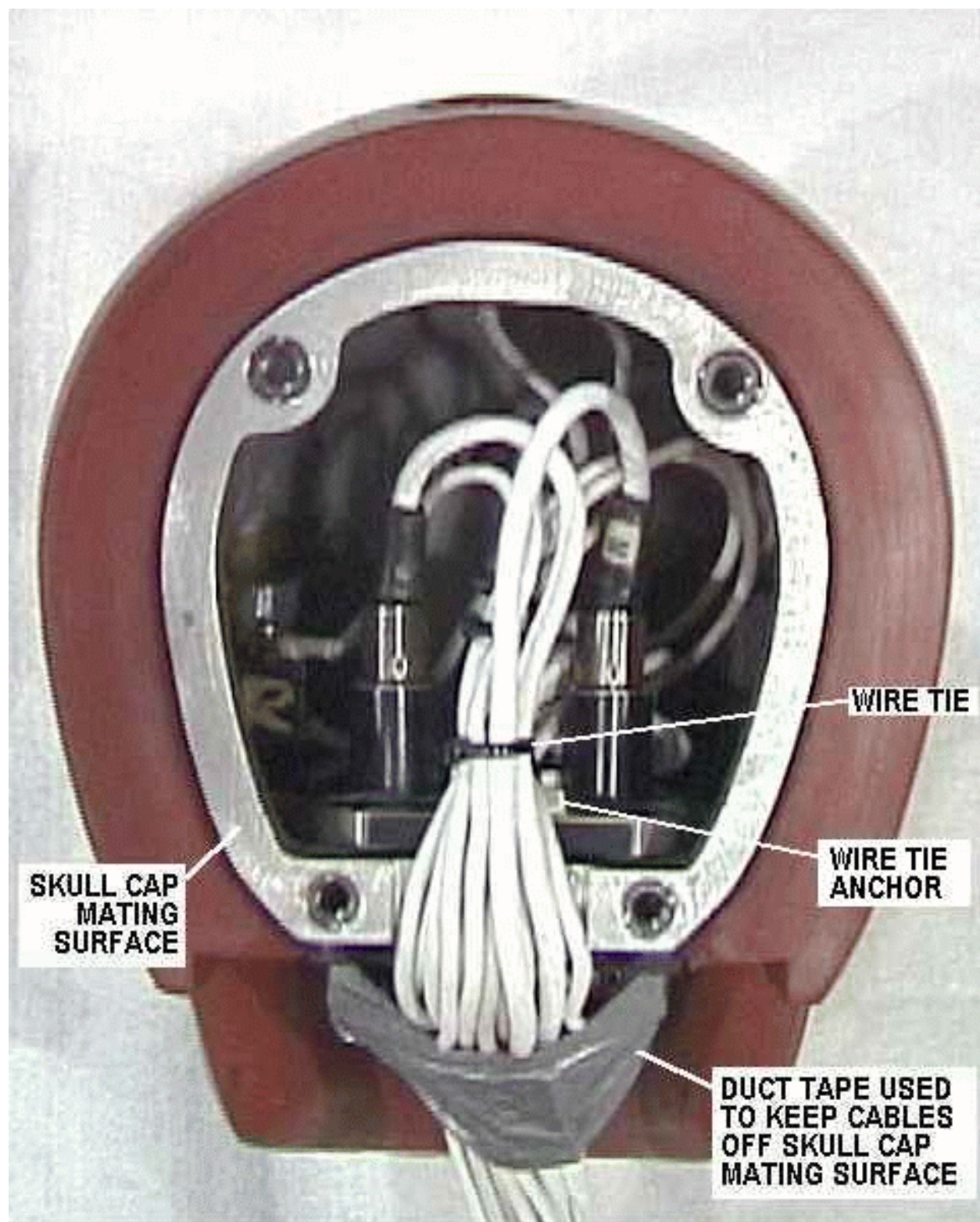


Figure 3.11 -- Cable routing

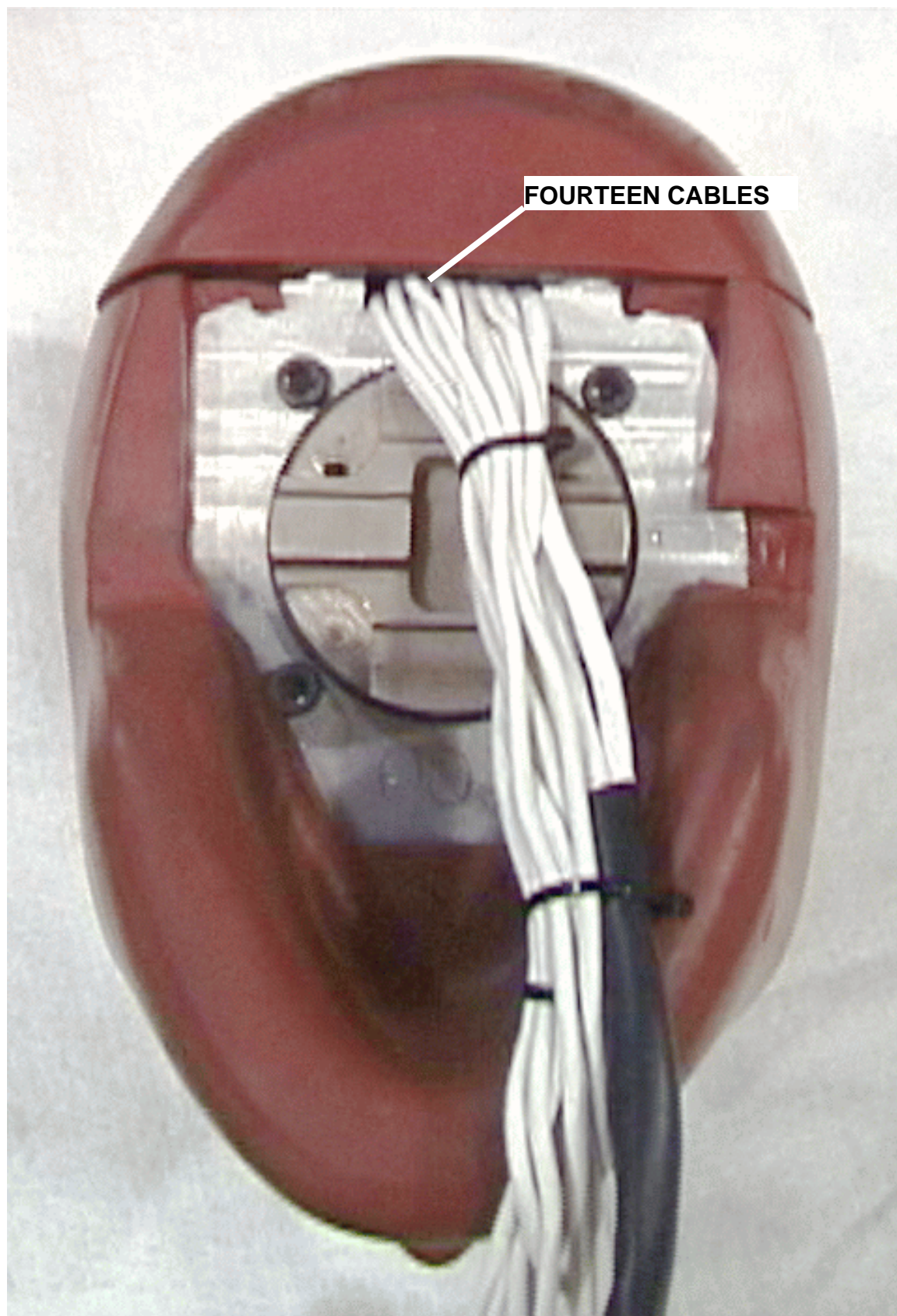


Figure 3.12 -- Cable routing with skull cap installed